SHIPBUILDING FOR BEGINNERS

BY

A. W. CARMICHAEL

Assistant Naval Constructor, U. S. N.

PUBLISHED BY
THE INDUSTRIAL SERVICE DEPARTMENT
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FOREWORD

This booklet is issued for use by workmen engaged in building ships contracted for by the U. S. Shipping Board, in the hope and confident expectation that it will prove of value to them in their service to the country.

Written in simple language and illustrated with clear diagrams, this booklet will serve both as a guide to the activities of a modern American shipyard and a stimulus to patriotic service.

Industrial Service Department,
U. S. Shipping Board Emergency Fleet Corporation.

Shipbuilding for Beginners

Object of This Pamphlet

It is only natural that a man who has work to do should be interested in knowing:

What he is to do;

Why he is to do it; and

How he should do it.

Furthermore a knowledge of these things will make him a better workman, thus not only rendering him of more service to his country, but also enabling him to make more wages for himself. A careful study of the following pages will assist a man starting work in a shipyard in attaining this knowledge.

General Remarks About Ships

Definition.—A *ship* is a large sea-going vessel, or, in other words, it is a structure that will float and is capable of making ocean voyages. There are many different kinds of ships—war ships and merchant ships, large and small, fast and slow, steel and wooden, designed and built for many different purposes—but all have certain characteristics in common. Therefore, in what follows, for the sake of brevity, consideration will be given only to steel merchant steamships.

Requirements.—The ship may be considered as a large *boat.* Being made of steel, which is heavier than water, it must be hollow and therefore, in order to float, it must be *watertight.*

In order to pass safely over the large waves of the ocean the ship must be given such a *shape* that it will not capsize and such *strength* that it will not break in two.

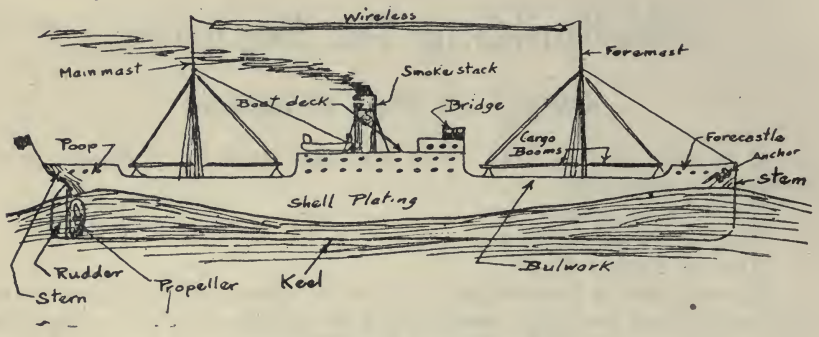
In other words the principal requirements of all ships are:

1. Watertightness.
2. Stability.
3. Strength.

The second of these, stability, depends upon the design of the ship—the shape of her hull, but the other two depend not only upon the design but upon the *workmanship*, and every workman who helps build the hull of a ship is responsible, to some extent, for her *watertightness* and *strength.*

Principal Parts.—The main essential of any ship is the *shell plating.* This forms the hull or outer skin of the ship, keeps out the water, helps to furnish strength and encloses all the other parts of the hull. It is made up of a great many steel plates, ranging in thickness from ¼ inch to 1 inch, depending on the size of the ship and the location of the plates. These plates are joined together by rivets. Inside of this plating, to support and stiffen it, is the *framing.*

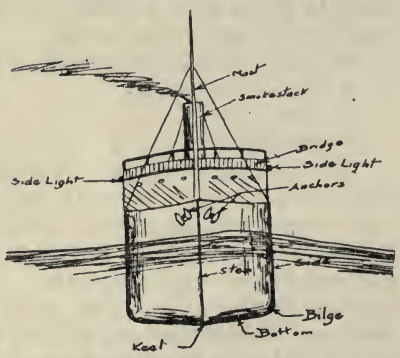
The rough sketch below gives a general idea of the appearance of a cargo ship, seen from one side.



SIDE VIEW OF A CARGO SHIP

As the ship moves ahead through the water the end that enters the water is the *forward* end of the ship, or the *bow*. The edge of the bow, which cuts the water, is called the *stem*. The other end of the ship, or *after* end is called the *stern*. The ship is driven forward by the *propeller* and is steered by the *rudder*. Running along the length of the ship at the middle of the bottom is the *keel* which furnishes longitudinal strength and forms the "backbone" of the ship. When looking from the stern towards the bow, or from *aft forward*, the side of the ship to the right hand is called the *starboard* side, and the side to the left hand, the *port* side. The forward upper portion of the ship is called the *forecastle* and the after upper portion, the *poop*. A little forward of the middle of the ship's length and at a considerable height above the water is located the *bridge* which is an enclosed platform for use of the captain and other officers who navigate and handle the ship. Special speaking tubes, telegraphs, etc., connect the bridge directly with the engine room.

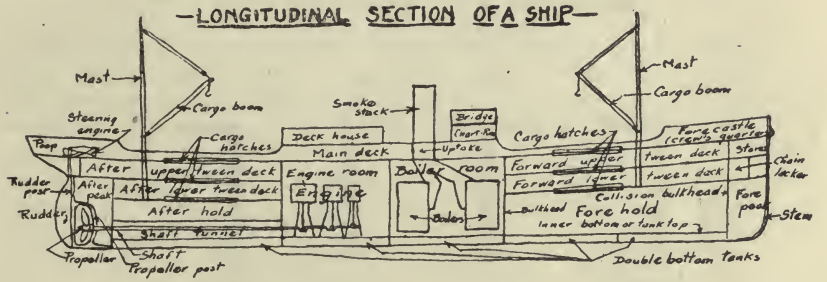
The second rough sketch gives an idea of the shape of the hull as seen from ahead of the ship. The *sides* are usually nearly straight and the *bottom* nearly flat but rising slightly on each side. The portion of the shell plating between the side and the bottom is called the *bilge*. When the ship is fully loaded a large portion of the hull is under water.



BOW VIEW OF CARGO SHIP

In order to show the main *structural* parts of a ship there is given below a *longitudinal section* or sketch showing the ship cut along the center line. The names of the various subdivisions or compartments are marked on this sketch. The *decks*, which are flat, or nearly flat and horizontal platforms, correspond to the floors

of a building. The *bulkheads* are vertical flat structures corresponding to the walls or partitions of a building. The *inner bottom* is a flat plated surface located two or three feet above the ship's bottom plating so as to form a double hull extending along the whole bottom of the ship. The inner bottom is also called the *tank-top,* as it forms the top of a number of *double bottom tanks.* These tanks are used for salt water ballast (to prevent the ship from being *"top heavy"* when carrying no cargo), for fresh water as reserve feed for the boilers, and, in the case of oil-burning ships, for fuel oil. The decks and bulkheads subdivide the hull into numerous compartments, thus increasing safety by limiting the amount of space that may be flooded in case the shell plating is damaged so that water can enter the hull. At the ends of the ship are large *peak* tanks which can be filled with water to *trim* the ship to an *even* (horizontal) *keel.* The boilers which furnish the steam power of the ship are located in one large compartment, several decks high, and the engine or engines in another similar compartment. Power from the engine to the propeller is transmitted by the shaft which extends



through the *shaft tunnel,* a long narrow passageway enclosed by steel plates. Cargo is carried in the *holds* and *tween-deck* spaces. *Living quarters* of officers and crew are located on the main and bridge decks. *Cargo hatches* are large openings in the decks through which cargo is lowered into the ship by means of *cargo booms* attached to the *masts.* These are either wooden or built up steel spars of great strength. The names of these various parts of a ship have been indicated in the sketches above.

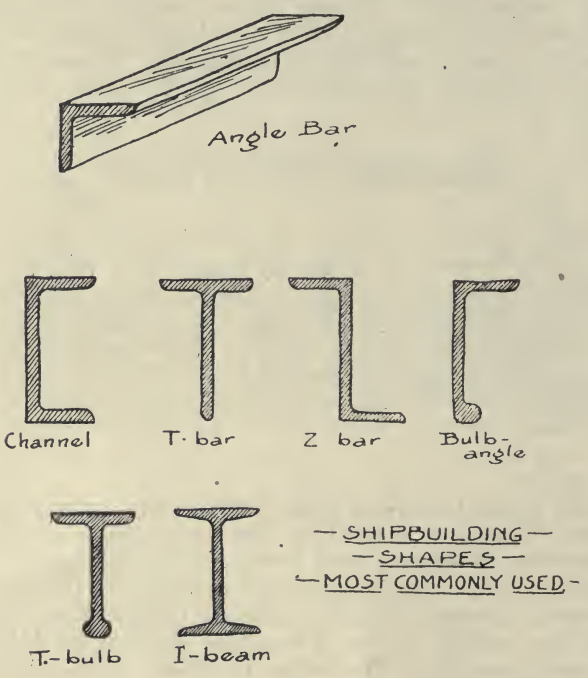
There are of course many parts of a ship not mentioned here because of lack of space. A ship, as well as being capable of floating and making trips on the ocean, must have practically all of the equipment of a building on shore—such as heating, lighting, ventilation, plumbing, refrigeration, means of communication, facilities for making repairs, etc., etc. Also she must have means of anchoring and mooring, boats and means for hoisting them, and various pumps and auxiliary machinery. With these the worker in a shipyard will gradually become familiar in the course of his work and no attempt will be made to describe them in detail in these pages.

Materials Used in Shipbuilding.—In a large modern cargo vessel

practically every material will be found used to some extent, but in the construction of the hull proper the principal material used is *mild steel* in the form of forgings, castings, plates, shapes and rivets.

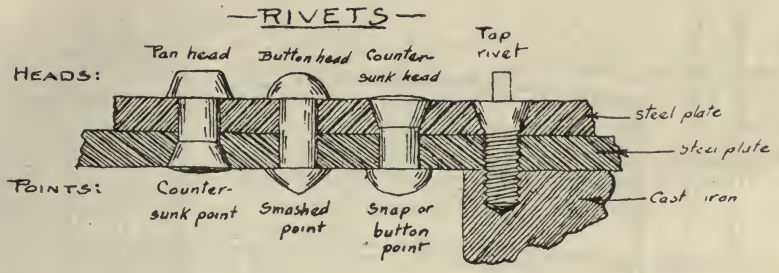
Forgings and *castings* are used for special purposes, of which the principal are the stem and stern post, rudder frame, propeller struts, etc.

Plates, which are simply flat sheets of steel of various thicknesses, are used to form the shell plating, decks, bulkheads, shaft tunnel, tank top, etc. Plates are usually spoken of by weight and a *twenty pound plate* means one that weighs twenty pounds *per square foot.* Such a plate is about ½ inch in thickness. A ten-pound plate is thus about ¼ inch thick, and so forth.



Shapes are used to form the framing and strength of the ship. They are long steel pieces, rolled to a constant cross section. The most common *shape* is the *angle bar* shown in the upper part of the sketch above. When the end is sawed off square the section thus made is L-shaped, or forms an *angle,* thus giving it its name. Sections of the other shapes ordinarily used—the *channel, T-Bar, Z-bar, bulb-angle, T-bulb* and *I-beam*—are also shown in the sketch.

Rivets are the small steel members used to connect the various plates and shapes together. Usually they are first heated red hot and driven or clinched with hammers or presses. The sketch shows different kinds of rivets, already driven, connecting two steel plates



and a portion of an iron casting. A rivet before being driven is a simple cylinder finished at one end with a *head.* Various forms of heads are shown in the sketch. The *point* of a rivet is formed, when it is driven, while the rivet is hot. Various forms of points are shown in the sketch. A *tap rivet* is not really a rivet, but a form of screw. After being tightly screwed in place and secured the square projecting portion shown in the sketch is cut off leaving a flat or *flush* head. Tap rivets are used for connecting thin to relatively thick parts.

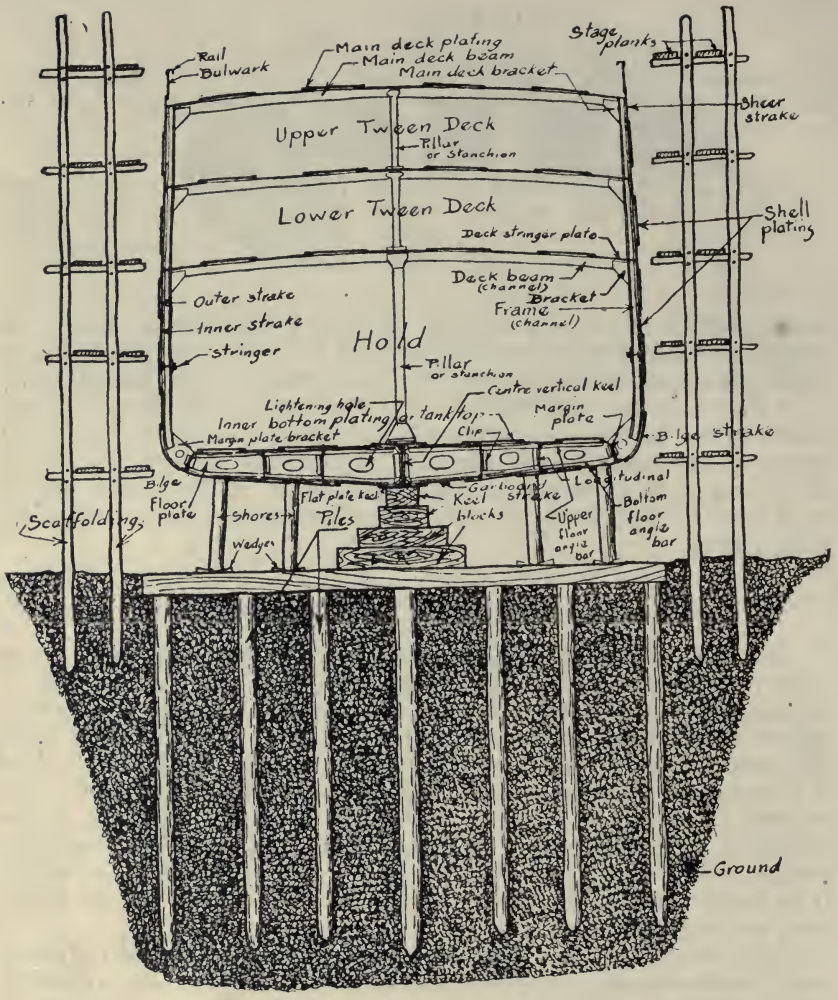
The Building of the Hull

The hull of a large ship weighs many hundreds of tons. It is built on the land, near the water's edge, and when completed, it is *launched,* or permitted to slide down specially prepared timbers, called *launching ways,* into the water. In order to support the large concentrated weight of the hull, while it is being built, and before it is launched, the ground must, in most cases, be strengthened. This is done by means of piling as shown on the following page in the sketch of the cross section of a ship being built. This sketch represents what would be seen if the ship and the ground on which it is being built be imagined as cut at right angles to the ship's keel, or length.

Piles, as shown, are driven deep enough into the ground to form a firm foundation and after being sawed off at the top are *capped* by cross timbers, of which one is shown in the sketch. On top of these cross timbers are placed heavy wooden blocks, called the *building* or *keel blocks.* These form the foundation on which the keel of the ship is laid. The keel usually consists of a number of long narrow and comparatively heavy steel plates, placed end to end, and extending from the stem to the stern frame. This is what is known as a *flat plate keel.*

The first step in the construction of the hull is the *laying of the keel.* This consists simply in laying the plates in place on top of the building blocks. The ends of the plates are connected together by short pieces of plates called *butt straps,* which overlap the ends.

On top of the flat plate keel and running vertically along its center line is placed the *center vertical keel* which consists, like the flat plate keel, of a number of flat rectangular plates, end to end, along the length of the ship.



Cross Section of a Ship Being Built

The next step in the work varies in different yards—some erect the plating of the bottom first, some erect the floor plates first. The *floor plates* form the lower portions of the transverse frames. They are deep flat plates extending between the inner and outer bottoms, placed vertically at right angles to the keel. They are secured to the center vertical keel at their inner ends and to the *margin plate* or edge of the inner bottom at their outer ends.

Where the plating of the bottom is erected first it is attached to the keel and gradually built out on each side, being supported by wooden *shores* as shown. After the keel, center vertical keel and bottom plating are erected and supported by suitable shoring the floor plates are placed in position. All of this material is bolted

in place as fast as it is erected. Angle bars are fitted to the top and bottom of each floor plate to connect it to the inner and outer bottom plating. *Longitudinals* are the plates running vertically and at right angles to the floor plates, between them. The floor plates are usually about two or three feet apart. The floor plates and longitudinals, with their connecting angle bars, form the *inner bottom framing.* To the top of this framing is attached the inner bottom and margin plating.

As the above work is progressing the stem and the stern frame are erected and attached to the ends of the keel.

When the inner bottom is erected the *transverse frames* or *frames,* as they are called, are erected and secured by *brackets* to the edge of the inner bottom. Their upper ends are connected, between each side of the ship, by the *deck beams.* There is usually a beam at each frame for each deck. The frames and their beams are numbered and the *strakes* (or rows) of shell plating are lettered for convenience in locating the various parts. During the early stages of construction the frames are held in position by long wooden strips called *ribbands,* running along the sides of the hull. The beams are connected to the frames by means of *brackets.* The beams are usually supported in the middle by vertical *pillars* or *stanchions.* At the same time that the frames and beams are being erected the bulkheads are also put in place. The bulkheads take the place of certain frames, being solid plate partitions running completely across the ship.

After the frames, beams and bulkheads are in place the plating of the sides of the hull and of the decks is installed. To furnish support for workmen engaged in working on the shell plating, deck beams, etc., scaffolding is erected as shown in the sketch.

After the various parts have been erected and carefully fitted in place the rivet holes are *reamed,* or made fair and smooth so as to take the rivets properly, and the work of rivetting commences. Certain rivetting must commence soon after the keel has been laid. In addition to the rivetting, certain plates must be made watertight by *calking.* (This will be described later.)

The above description will give a general idea of the work of building the hull of a ship prior to launching. Only the more important points have been taken up. After the hull proper is completed a large amount of work on finishing the interior, installing various piping, wiring, auxiliary machinery, fittings, etc., must be done, but as this is of miscellaneous character no attempt will be made to give a detailed description of it here.

Principal Shipbuilding Trades

Names of Principal Trades.—The work of building a ship from the time that it is decided upon until the ship is actually in commission is done by a large number of different classes of workmen. These include such trades as shipfitters, blacksmiths, rivetters, chippers and calkers, drillers, plumbers, pipefitters, machinists, joiners, carpenters, pattern makers, foundrymen, coppersmiths, sailmakers,

wood calkers, heavy forgers, sheet metal workers, furnace men, shearers, punchers, anglesmiths, shipwrights, riggers, flangers, drop forgers, erectors, bolters-up, crane men, locomotive engineers, firemen, loftsmen, laborers, painters and helpers in all of these trades.

The more important trades employed in the actual construction of the hull of the ship, however, are as follows:

1. Loftsmen,
2. Shipfitters,
3. Drillers,
4. Rivetters,
5. Chippers and Calkers,
6. Shipwrights,
7. Riggers,
8. Shop Workers.

Loftsmen.—The plans of the ship, as made in the drafting room, are drawn to small scale. These are sent to the *mould loft*—a large building with a smooth floor of sufficient size to have drawn upon it the plans of the ship to full size. This work is done by the *loftsmen.* The *lines* of the ship consist of three different plans called the *sheer plan* (side elevation), the *half-breadth plan* (plan) and the *body plan* (end-elevation). The shape of the ship is given by these three plans and from them *templates* or *moulds* can be made by the loftsmen. These templates or moulds are light wooden or paper patterns from which the steel for the various parts of the hull can be laid off and marked for shearing, punching, planing, etc. The plan most used in making templates is the body plan—which shows the shape of each frame, beam and floor plate—and this is usually marked off on a special section of wood flooring (called the *scrieve board*) and cut into it permanently with a scrieve knife.

The duties of the loftsmen are to lay down and fair the lines on the mould loft floor, to make the scrieve board, and to make the various moulds or templates for the parts of the hull. This work requires considerable experience and a certain knowledge of mathematics including geometry. A large responsibility rests upon the loftsmen, for if their templates are not properly made the parts of the hull will not join together properly to form the completed structure. This would cause serious delays, the extra expense of making new parts, or the danger of weakening the hull of the ship.

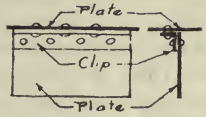
Shipfitters.—The shipfitter (sometimes called "fitter-up") is probably the one metal worker whose trade may be said to be purely a shipbuilding trade. His work consists in marking off the steel material for different parts of the ship's hull. This is usually done by means of a template *lifted* or marked off from other parts already in place on the ship. In some cases the material is marked off directly, without the use of a template, from dimensions taken from a blue print or other plan.

It will thus be seen that there are three different ways of marking material for fabrication: (1) From templates made in the mould loft by the loftsmen, (2) from templates made on the ship by shipfitters, (3) from blue prints, directly, by shipfitters. The

amount of material marked off in each of these three different ways varies in different shipyards, according to yard practice.

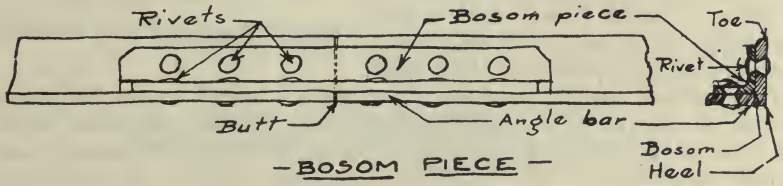
A few of the simpler parts, usually laid off by the shipfitters are illustrated in the following sketches.

A *clip* is simply a short piece of angle bar used to connect two other parts at right angles, or nearly at right angles. The ends of the clip must be marked off so that it can be sheared to the proper length and the locations of the centers of the rivet holes and their diameters indicated so that these holes may be properly punched. When the clip is completed it should bolt in place with the rivet holes in it agreeing perfectly with those in the two parts that it connects.



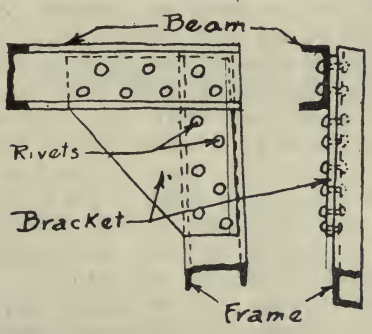
—CLIP CONNECTING TWO PLATES—

A *bosom piece* is a short section of angle bar used to connect, or form a sort of butt strap for, the ends of two angle bars in the same line. The thickness of the flanges of the bosom piece should be



—BOSOM PIECE—

slightly greater than those of the angle bars that it connects. The heel of the bosom piece must be planed off to fit into the bosom of the angle bars, as shown in the sketch. The toes of the bosom piece are planed off so as not to project beyond those of the angle bars.

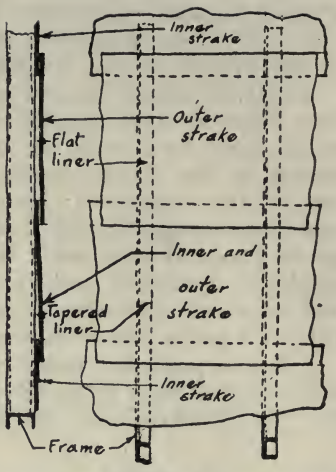


—BEAM BRACKET—

A *bracket* is a flat plate, usually of the shape shown in the sketch, used to connect two parts such as a deck beam and frame. The bounding edges and the locations of the rivet holes, with their diameters, are marked off on the flat plate for shearing and punching. The rivet holes in the bracket must agree perfectly, or come *fair*, with the holes in the frame.

Shell plates are more difficult work and are laid off only by thoroughly experienced shipfitters. The sketch shows the various kinds of shell plating. *Strakes* is the name given to the rows of shell plating which extend fore and aft or at right angles to the frames. They are usually arranged alternately, *inner* and *outer* strakes, the former being fitted directly against the frames and the latter overlapping the edges of the two adjacent inner strakes. In some cases one edge of a strake is an *inner* and the other edge an *outer*. In order to give strength and stiffness, *liners* must be

fitted between outer strakes and each frame that they cover. These are *flat* or *straight* liners. Liners are also necessary under the inner-and-outer strake plating. These must be *tapered.* The ends of adjacent plates in any strake are connected by butt straps. In laying out shell plates reference is made to the *shell expansion* plan which shows the size and spacing of rivets, size and thickness of butt straps, etc.



—SHELL PLATING AND LINERS—

The work done by a shipfitter is very important for if his work does not come absolutely true and fair the watertightness, strength, and consequently the safety of the ship may be seriously affected. A shipfitter must be able to "read plans" and a full knowledge of his work can only come from practical experience. Any man desirous of becoming a good shipfitter should spend as much time as possible in studying practical shipbuilding by means of plans, books and general observation. Intelligent shipfitter's helpers usually can become shipfitters after obtaining a certain amount of experience and knowledge.

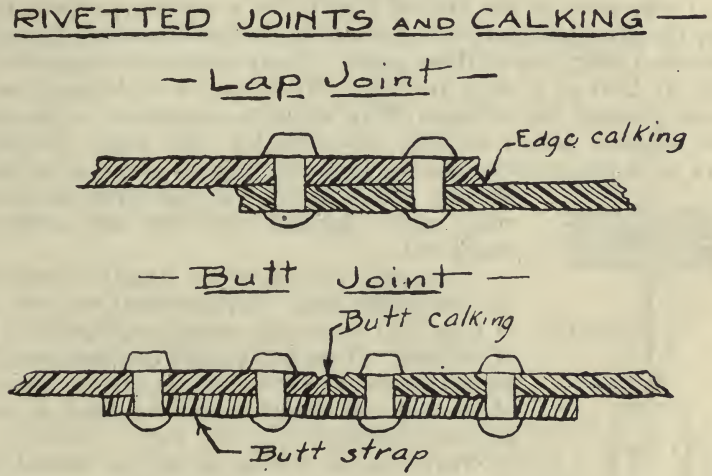
Drillers.—Workmen of this trade usually do both drilling and reaming. A large portion of the rivet holes in the different parts of a ship are punched in the shop before the parts are erected, but in some cases the holes must be drilled on the ship. When the parts that are punched are fitted in place, in spite of the most careful workmanship, it will usually be found that many of the rivet holes in connecting pieces do not come quite fair, that they overlap slightly. These unevennesses are removed by *reaming* which consists in slightly enlarging the holes so as to make them fair and perfectly cylindrical so that they will be completely filled by the rivets. When holes are very unfair, so that reaming would enlarge them to a great degree the work should not be reamed, as this would impair the strength. A new part must be made to remedy the defect.

Rivetters.—The rivetting of a ship is what holds the various parts together and gives to the hull its watertightness, strength and safety. Each rivet must be driven carefully, exactly as called for by the plans. When the ship is designed, each and every rivet is specified in order to serve a certain purpose, and if not driven as intended the safety of the ship may be impaired.

The actual method of driving rivets can be learned only by experience, but every member of a rivetting gang should realize the importance of his work, and his responsibilities. He is assisting in the *final completion* of the hull; and his work, which supplements that of all the others that have preceded him, gives to the ship her strength and safety. The lives of many men may depend upon how

well his work has been done. (See more detailed discussion under "Responsibility of the men who build ships.")

Chippers and Calkers.—It is sometimes necessary to trim off or smooth up the edges of plates, castings, etc., or to cut holes in them after they are in place on the ship. This is done by chippers using hand or pneumatic tools. These same workmen, usually, are also employed as calkers. Their duty is to calk the edges of plates, angles, rivet heads, etc., so as to make them watertight. This calking is done after the riveting is completed and it is very important that it be well and carefully done. The calking chisel or tool is used to force one part of metal tightly against another. The two principal kinds of calking—edge calking and butt calking—are illustrated in the sketch. If calking is not properly done water will enter between the parts of the joint, causing corrosion, and, in time, serious weakness to the ship's structure. In some parts of a ship even the slightest leakage might be dangerous.



Shipwrights.—The shipwrights are the workmen who install wood decks, wood foundations for capstans, winches, guns, etc., and who do the work of making and installing wooden masts, spars, booms, etc. They also have considerable work to do in connection with the preparation of launching ways, building blocks, shores, wedges, etc. Their work is distinct from woodwork on stateroom fittings, furniture, etc., and other woodwork of similar nature that is done by the *joiners.*

Riggers.—The work of the riggers consists in the manufacture and installation of shrouds, stays, lifts, braces, life lines, and other rigging fitted to the masts, spars, booms and other parts of the ship. Some of this rigging is made of steel wire rope, and some of hemp or manila rope. The riggers must be able to do splicing, seizing, serving, parcelling, etc.

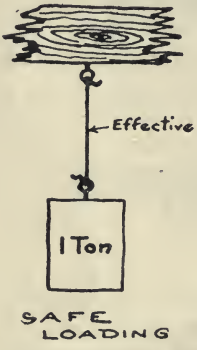
Shop Workers.—The workmen employed in the shops of a shipyard comprise a great variety of trades. For example, a large amount of the woodwork of a ship is done in the shop by the *joiners.*

Ventilation, piping and all light metal plating work is done largely in the shop by the *sheet metal workers.* Plumbing and piping work is done to a large extent in the shop by the *plumbers, machinists* and *pipefitters.* Forgings for a large number of miscellaneous fittings and other parts of the ship are made in the shop by *blacksmiths, drop-forgers, heavy forgers,* etc. Much of the work on wiring and electrical fittings is done in the shop by the *electricians.*

The shop work on the hull proper, or the *fabrication,* as it is sometimes called, is done by the workmen who operate the *shears, punches, bending rolls, planers,* and other shop machines, and the *frame benders, acetylene burners, furnace men,* and *angle-smiths,* who do the work necessary, prior to erection, on keel plates, shell plates, frames, reverse frames, longitudinals, stringers, floor plates, brackets, clips, beams, bulkhead and deck plating, stiffeners, and other parts required for the hull of the ship.

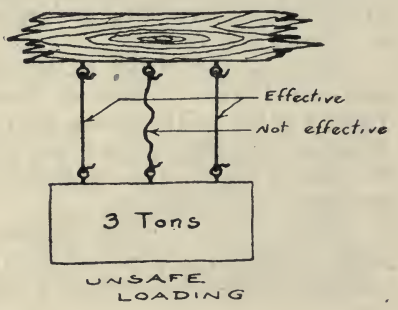
Responsibility of the Men Who Build Ships

Every part of the hull of a ship has a certain purpose to serve, and the strength and usefulness of the ship as a whole depend upon each and every one of these parts. Every workman engaged in building the hull of a ship, from the draftsman who designs the parts, down through the loftsmen, shop workers, and fitters, to the riveters and calkers, has a certain responsibility, and upon the skill and care with which each does his part may depend the lives of hundreds of men. In time of war the lives of thousands, even, might depend upon the safe arrival of a single ship.



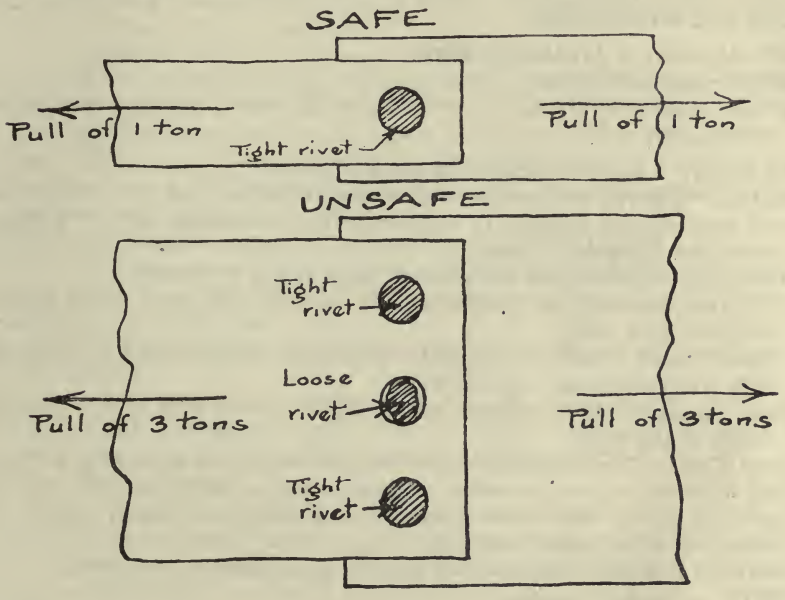
This principle may be simply illustrated in the following way. Suppose that we have a piece of rope that is strong enough to support a weight of one ton. If such a weight be suspended by this piece of rope, as shown in the sketch, the strength of the rope is effective and we have a condition of *safe loading.*

Three pieces of this same rope would support a weight of three tons provided each piece of rope becomes effective. In the sketch below, where one piece of rope is longer than the other two, this long piece is *not* effective, the other two pieces can support only *two* tons, and we have a case of *unsafe* loading. The two outer ropes would break and the 3-ton weight would fall. The strength of the two outer ropes is lost because of the lack of effective strength of the third.



If we consider now the parts of a ship, a similar principle will be found to apply. In the upper sketch, page 17, is shown a case of safe loading, in which a pull of one ton is taken by a single rivet that joins two plates. This rivet is sufficiently strong to take this pull. Three of these rivets should be

strong enough to take a pull of three tons, but in the lower (page 17) sketch one of the rivets has not been properly driven. Either because the rivet holes were not properly laid and punched, or because they were not properly reamed, or because the rivet itself was not properly driven, this rivet is not effective. It offers no resistance to the 3-ton pull, which thus comes upon *two* rivets that are not sufficiently strong and we have another case of unsafe loading. Under a pull of three tons this joint would be ruptured.



Similarly each joint forms a part of the strength of the whole ship, and if defective rivets cause the failure of a joint, the added stress thus put upon the other parts may be greater than they can bear and the whole ship may break in two. Such cases have actually happened.

When a ship is in a hurricane at sea her safety depends upon her strength and the workmen who built that ship are directly responsible for the lives of all on board. It is therefore important for each man working in a shipyard to do his work conscientiously and with every bit of care and intelligence of which he is possessed.

Shipbuilding Terms

For the convenience of beginners there is given below a list, alphabetically arranged, explaining briefly the meanings of some of the words, phrases, etc., most commonly used in connection with ships and shipbuilding:

AFT—at, near, or toward the stern.

AFTER—nearer the stern.

AFTER PERPENDICULAR—a vertical straight line at the after edge of the rudder post.

AIR PORT—a circular opening in the ship's side.

ANCHOR—a heavy steel device that is attached to the end of a large chain or hawser to be dropped to the bottom for holding the ship in position when not alongside a dock.

ATHWARTSHIPS—across the ship, at right angles to the keel.

AUXILIARIES—various winches, pumps, motors, and other small engines required on a ship.

BALLAST—any weight or weights (usually sea water) used to keep the ship from becoming "top heavy."

BEAM—an athwartship member supporting a portion of a deck. Also the width of the ship.

BEAM KNEE—The enlarged end of a beam, by which it is attached to a frame.

BELOW—below a deck or decks (corresponding to "down stairs").

BENDING SLAB—heavy cast iron blocks arranged to form a large solid floor on which frames are bent.

BENDING ROLLS—large machine used to give curvature to plates.

BERTH—a place for a ship.

BEVEL—the angle between the flanges of a frame or other member. (When greater than a right angle, *open* bevel; when less, *closed.*)

BILGE—the rounded portion of the hull between the side and bottom.

BILGES—the lowest portion of the ship inside of the hull.

BILGE KEEL—a fore and aft member fitted to the outside of the shell plating running along the bilge, used to prevent excessive rolling of the ship.

BITTS—heavy steel castings fitted to the weather deck for securing mooring lines or hawsers.

BOOM—a long round heavy spar, pivotted at one end, usually used for hoisting cargo, etc.

BOSOM PIECE—butt strap for angle bars.

BOSS—the curved swelling portion of the ship's hull around the propeller shaft.

BOW—the forward end of a ship.

BRACKET—a small plate used to connect two or more parts, such as deck beam to frame, frame to margin plate, etc.

BREAST HOOK—a plate structure fitted inside the hull near the bow to give local strength to the shell plating.

BRIDGE—the athwartship platform above the weather deck from which the ship is steered, navigated, etc.

BUILDING SLIP—place where the ship is built, before launching.

BULKHEAD—a vertical partition corresponding to the wall of a building, extending either athwartships or fore and aft.

BULWARK—the ship's side above the weather deck.

BUNKER—a compartment used for the stowage of coal or other fuel.

BUOYANCY—ability to float, or the difference between the weight of the ship and the upward force of the water that it may displace.

BUTT—the joint formed when two parts are placed end to end.

BUTT STRAP—a small plate or other member used to connect the two parts of a butt by overlapping each.

CAMBER—the thwartship curvature of a deck. Sometimes called *round up.*

CALK—to make a joint water tight.

CANT FRAME—a frame not square to the keel line.

CAPSTAN—a revolving device, with axis vertical, used for heaving in lines.

CARGO—the freight carried by a ship.

CARGO HATCH—large opening in a deck to permit loading of cargo.

CARGO BOOM—heavy boom used in loading cargo.

CARLING—fore and aft member at side of hatch, extending across ends of beams where cut to form hatch.

CENTRE LINE—the middle line of the ship, from stem to stern.

CHAIN—usually refers to heavy chain attached to anchor.

CHAIN LOCKER—compartment in forward lower portion of ship in which anchor chain is stowed.

CHART HOUSE—small room under bridge used for charts and navigational instruments.

CHOCK—a heavy fitting through which ropes or hawsers may be led.

CLEAT—a fitting attached to the deck, having two fore and aft arms or projections around which a rope or line may be secured.

CLIP—a short angle bar.

COAMING—the vertical boundary of a hatch or skylight.

COFFERDAM—the space between two bulkheads located very close together.

COMPARTMENT—a subdivision of space or room in a ship.

COUNTERSINK—the taper of a rivet hole for a flush rivet.

DAVIT—heavy vertical pillar, of which the upper end is bent to a curve, used to support the end of a boat when hoisting or lowering.

DEAD FLAT—the middle of the length of a ship, where the frames change from looking forward to looking aft.

DEADWEIGHT—the total weight of cargo, fuel, water, stores, passengers and crew, and their effects, that a ship can carry.

DECK—the part of a ship that corresponds to the floor of a building.

DECK BEAM—athwartship support of deck.

DECK STRINGER—the strip of plating that runs along the outer edge of a deck.

DERRICK—a device for hoisting heavy weights, cargo, etc.

DISPLACEMENT—the total weight of the ship when afloat, including everything on board.

DOG—a small bent metal fitting used to close doors, hatch covers, manhole covers, etc.

DOUBLE BOTTOM—compartments at bottom of ship between inner and outer bottoms, used for ballast tanks, water, fuel oil, etc.

DOUBLING PLATE—a plate fitted outside or inside of another to give extra strength or stiffness.

DRAG—the amount that one end of the keel is below the other when the ship is afloat but not on an even keel.

DRAFT—the vertical distance of the lowest part of the ship below the surface of the water when she is afloat.

DRIFT PIN—a small tapered tool used to draw adjoining parts together so that the rivet holes will come fair by driving it into these holes.

EYE BOLT—a bolt formed with an eye or ring at one end.

ERECTION—the process of hoisting into place and bolting up the various parts of the ship's hull, machinery, etc.

EVEN KEEL—a ship is said to be on even keel when the keel is level, or parallel to the surface of the water.

FAIR—smooth without abruptness or unevenness, in agreement. Fairing the lines consists in making them smooth. Rivet holes are fair when they agree one with another in adjoining members.

FAIRLEAD—a small fitting through which a rope, line, etc., may be led so as to change its direction without excessive friction.

FAYING SURFACE—the surface between two adjoining parts.

FENDER—a fitting or device to prevent damage to a ship's hull at or near the waterline by other vessels, floating objects, docks, etc.

FIDLEY HATCH—hatch around smokestack and uptake.

FIRE CONTROL—means for informing men at the guns how to set the sights, at what target to fire, etc.

FLAGSTAFF—flag pole at stern of ship.

FLANGE—portion of a plate or shape at, or nearly at right angles to main portion.

FLAT—a small partial deck, built level, without curvature.

FLOOR—the lower portion of a transverse frame, usually a vertical plate extending from center line to bilge, and from inner to outer bottom.

FORE AND AFT—in line with the length of the ship, longitudinally.

FORECASTLE—the forward upper portion of the hull, usually used for the crew's quarters.

FORE PEAK—a large compartment or tank just aft of the bow in the lower part of the ship.

FORGING—a mass of steel worked to a special shape by hammering while red hot.

FORWARD—near or toward the bow.

FRAMING—the support and stiffening of the shell plating, deck plating, etc. Usually consists of the ordinary transverse frames or "ribs," beams, floors, etc., and the longitudinal framing or keel, keelsons, longitudinals, stringers, etc.

FRAME SPACING—the fore and aft distance between adjacent frames.

FREEBOARD—the vertical distance from the upper watertight deck or top of bulwarks to waterline, when ship is fully loaded.

FREEING PORT—an opening in the ship's side to allow water to run overboard.

GALLEY—the "kitchen" of a ship.

GALVANIZING—coating metal parts with zinc for protection from rust.

GANGWAY—a passageway, a ladder or other means of boarding a ship.

GARBOARD STRAKE—the strake of shell plating next to the keel.

GROSS TONNAGE—a figure obtained by dividing the total volume of the ship, in cubic feet, by 100.

GROUND WAYS—timbers fixed to the ground, under the hull on each side of the keel, on which she is launched.

GUDGEON—fitting on which rudder swings. The gudgeons fit around the *pintles*, and form a part of the rudder post.

GUNWALE—the side of a ship at the edge of the weather deck.

HARPIN—a curved wooden piece used to hold frames at ends of ship in position when first erected.

HATCH—an opening in a deck.

HAWSE PIPE—a large fitting attached to the bow of a ship through which the anchor chain passes.

HAWSER—a large rope.

HELM—the direction to which the tiller is put, or opposite to which the rudder is put. (When the rudder is to port the ship is said to carry starboard helm.)

HOGGING—straining of the ship that tends to make the bow and stern lower than the middle portion.

HOLD—a large compartment in the lower part of the ship for cargo.

HOLD BEAMS—beams in a hold, similar to deck beams, but having no plating or planking on them.

HULL—the body of a ship, including shell plating, framing, decks, bulkheads, etc.

INBOARD—inside the ship, toward the center line.

INNER BOTTOM—plating forming the upper boundary of the double bottom. Also called *tank top.*

INTERCOSTAL—made in separate parts between frames, beams, etc.; the opposite of continuous. (Floors are continuous; longitudinals, intercostal in a merchant ship.)

ISHERWOOD SYSTEM—a system of building ships in which the main framing is longitudinal or fore and aft, instead of transverse as in ordinary ships.

JACKSTAFF—flag pole at bow of ship.

JOGGLING—offsetting the edges of plates of outer strakes to avoid the use of liners.

KEEL—the fore and aft member, usually in the form of flat plates end to end, extending from stem to stern along the bottom of a ship on the center line.

KEELSON—an auxiliary keel or stringer, extending along and over, or parallel to the keel. The center vertical keel.

LADDER—inclined steps, taking aboard ship the place of "stairs."

LAP—a joint in which one part overlaps the other, thus avoiding the use of a butt strap.

LAUNCHING—the operation of placing the hull in the water by having it slide down the *launching ways.* During launching the weight of the hull is borne by the *sliding ways* which are attached to the hull and slide with it down the *ground ways.*

LAYING OFF—marking plates, shapes, etc., for shearing, punching, etc.

LENGTH BETWEEN PERPENDICULARS—the length of a ship measured from the stem to the after perpendicular.

LENGTH OVER ALL—the length of a ship measured from the stem to the aftermost point of the stern.

LIGHTENING HOLE—a large hole cut in a floor plate, longitudinal, etc., to reduce its weight.

LIMBER HOLE—a hole of a few inches diameter cut in a floor plate to allow water to drain through it near the bottom.

LINER—a flat or tapered strip placed under a plate or other part to bring it in line with another part that it overlaps.

LINES—the plans of a ship that show its form. From the lines, drawn full size on the mould loft floor, are made templates of the various parts of the hull.

LONGITUDINAL—a fore and aft vertical member running parallel, or nearly parallel, to the center vertical keel through the double bottom. In merchant ships longitudinals are intercostal.

MARGIN PLATE—the outer boundary of the inner bottom, connecting it to the shell plating at the bilge.

MAGAZINE—a compartment or room in which ammunition is stored.

MAIN DECK—the principal deck of the main hull, being the highest of, and giving strength to, the main hull.

MANHOLE—a round or oval shaped hole cut in a bulkhead, tank top, etc., large enough for a man to pass through.

MAST—a large long spar, placed nearly vertical on the center line of a ship.

MIDSHIP—at the middle of the ship's length.

MIDSHIP SECTION—a plan showing a cross section of the ship amidships. This plan shows sizes of frames, beams, brackets, etc., and thicknesses of plating.

MOULD LOFT—a shed or building with large, smooth floor on which the lines of a ship can be drawn to full scale.

MOULD—a light pattern of a part of a ship. Usually made of thin wood or paper. Also called a *template.*

MOORING—securing a ship in position by several lines or cables, so that she cannot move or swing.

NET TONNAGE—a figure obtained by making deduction from the gross tonnage to allow for space not available for carrying cargo.

OIL TIGHT—rivetted and caulked to prevent oil leakage. (Rivets must be more closely spaced for this purpose than for water tightness.)

ON BOARD—on or in the ship.

ON DECK—on the upper deck, in the open air.

ORLOP DECK—the lowest deck.

OUTBOARD—away from the center line, towards the side of a ship.

OVERBOARD—outside, over the side of a ship. Into the water.

OVERHANG—portion of the hull over, and unsupported by the water.

PANTING—in and out movement of shell plating.

PILLAR—vertical member or column giving support to a deck. Also called *stanchion.*

PINTLE—fitting or pin on the rudder which turns in a gudgeon.

PLAN—a drawing prepared for use in building a ship.

PLANKING—wood covering for decks, etc.

PLATFORM—a partial deck.

PLATING—the plates of the shell, a deck, a bulkhead, etc.

POOP—the after, upper portion of the hull, usually containing the steering gear.

PORT—the left hand side of the ship when looking from aft forward. Also an opening.

PORTHOLE—a circular opening in the ship's side.

PROPELLER—a revolving device that drives the ship through the water, consisting of three or four blades, resembling in shape those of an electric fan.

PUNCH—a machine for punching holes in plates and shapes.

QUADRANT—a fitting on the rudder head to which the steering chains are attached.

QUARTER—a side of the stern.

QUARTER DECK—that portion of the weather deck nearest the stern.

QUARTERS—compartments, rooms and other portions of the ship used for living spaces.

RABBET—a depression or offset designed to take some other adjoining part; as, for example, the rabbet in the stem to take the shell plating.

RAIL—the upper edge of the bulwarks.

REAMING—enlarging a rivet hole by means of a revolving, cylindrical, slightly tapered tool with cutting edges running along its sides.

REVERSE FRAME—an angle bar or other shape rivetted to the inner edge of a transverse frame to reinforce it.

RIBBAND—a fore and aft wooden strip or heavy batten used to support the transverse frames temporarily after erection.

RIGGING—ropes, wire ropes, lashings, etc., used to support masts, spars, booms, etc. Also the handling and placing on board the ship of heavy weights, machinery, etc.

RISE OF BOTTOM—the amount that the flat portion of the bottom of the ship rises from the keel to the side of the ship.

RIVET—a short metal connection of two or more members usually driven or clinched after being heated red hot.

ROLL—motion of the ship from side to side alternately raising and lowering each side of the deck.

RUDDER—a large, heavy fitting hinged to the rudder post. Used for steering the ship.

RUDDER POST—heavy vertical post at after end of stern frame under water which supports rudder.

RUDDER STOP—fitting to limit the swing of the rudder.

SAGGING—straining of the ship that tends to make the middle portion lower than the bow and stern.

SAMSON POST—a heavy vertical post that supports cargo booms.

SCANTLINGS—the dimensions of various parts of the ship.

SCRIEVE BOARD—a large section of flooring in the mould loft in which the lines of the body plan are cut with a knife. Used for making moulds of the frames, beams, floor plates, etc.

SCUPPER—a drain from the edge of a deck discharging overboard.

SEAM—fore and aft joint of shell plating.

SEAM STRAP—butt strap of a seam.

SET IRON—bar of soft iron used on bending slab to give shape of frames.

SHAFT—long, round, heavy forging connecting engine and propeller.

SHAFT TUNNEL—enclosed alley-way around shaft extending from engine room to after peak tank.

SHAPE—long bar of constant cross section, such as a channel, T-bar, angle bar, etc.

SHEARS—large machine for cutting plates and shapes.
SHEER—fore and aft curvature of a deck.
SHEER PLAN—side elevation of ship's form.
SHEER STRAKE—the upper strake of the main shell plating, just below the bulwarks.
SHELL EXPANSION—a plan showing details of all plates of the shell.
SHELL LANDINGS—points on the frames showing where the edges of shell plates come.
SHELL PLATING—the plates forming the outer skin of the hull.
SHORE—a large round wooden brace.
SKYLIGHT—an opening in a deck to give light and air to the compartment below it.
SLIDING WAYS—see *launching*.
SMOKE STACK—large vertical pipe or funnel for exit of smoke from boilers.
SOUNDING PIPE—vertical pipe in oil or water tank used to measure depth of liquid in tank.
SPAR—a long, round, wooden timber.
SPAR DECK—upper deck.
STABILITY—tendency of a ship to remain upright.
STANCHION—a pillar or upright post, a pillar.
STAPLING—collars, forged of angle bars, to fit around continuous members passing through bulkheads, for water tightness.
STARBOARD—the right-hand side of the ship when looking from aft forward. Opposite to port.
STEALER—a strake of shell plating that does not extend completely to the bow or stern.
STEERING GEAR—apparatus for controlling the rudder.
STEM—forging or casting forming extreme bow of ship, extending from keel to forecastle deck.
STERN—after end of ship.
STERN FRAME—large casting attached to after end of keel to form ship's stern. Includes rudder post, propeller post, and aperture for propeller.
STIFFENER—an angle bar, T-bar, channel, etc., used to stiffen plating of a bulkhead, etc.
STOP WATER—canvas and red lead or other material fitted between two metal parts to make a watertight joint.
STRAKE—a fore and aft course or row of shell or other plating.
STRINGER—a fore and aft continuous member used to give longitudinal strength. According to location are called *hold stringers*, *bilge stringers*, *side stringers*, etc.
STRUT—a heavy arm or brace.
TANK TOP—the inner bottom.
TELEGRAPH—means of signalling from bridge to engine room, etc.
TEMPLATE—a mould.
TIE PLATE—a single fore and aft course of plating attached to deck beams under wood deck to give extra strength.
TILLER—arm attached to rudder head for operating rudder.
TRANSOM—the aftermost transverse frame.
TRANSVERSE—athwartships, at right angles to the keel.
TRANSVERSE FRAMES—vertical athwartship members forming the ship's "ribs."

TRIM—amount ship is off from an even keel.
TUMBLE HOME—an inboard sloping of the ship's side above the level of greatest beam.
UPPER DECK—the highest complete deck.
UPTAKE—connection between boilers and smoke stack.
VERTICAL KEEL—row of plating extending vertically along center of flat plate keel. Sometimes called *center keelson.*
VENTILATOR—a device for furnishing fresh air to compartments below decks.
VOICE TUBE—large speaking tube.
WAYS—timbers, etc., on which a ship is built or launched. See *launching.*
WATER LINE—the line of the water's edge when the ship is afloat.
WATERTIGHT—so riveted or calked as to prevent the passage of water.
WATERWAY—a narrow passage along the edge of the deck for the drainage of the deck.
WEATHER DECK—a deck with no overhead protection.
WEB—the vertical portion of a beam, the thwartship portion of a frame, etc.
WEB FRAME—a frame with a deep web.
WELDING—making a joint of two metal parts by fusing more metal in between them.
WINCH—a small hoisting engine.
WINDLASS—the machine used to hoist the anchors.
YARD—a horizontal, thwartship, spar fitted to a mast.

Conclusion

After reading this booklet through carefully at home take it with you to the shipyard. During the noon hour or after working hours take it onto the ship and locate each part mentioned in the booklet. You will thus quickly get the whole subject fixed in your memory. Until you have learned the names of all the parts mentioned, carry the booklet in your pocket so that you can refer to it when necessary.